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Quarterly Report

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Prepared for: United States Department of Transportation
Pipeline and Hazardous Materials Safety Administration
Office of Pipeline Safety

Project Title: "Understanding Magnetic Flux Leakage (MFL) Signals from Mechanical Damage in Pipelines"

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Background

In an effort to improve safety and minimize environmental impact, there is increasing emphasis of pipeline operators and inspection vendors to locate and accurately assess mechanical damage. Caliper tools can be used to predict sizes of simple dents, but cannot detect the presence of external gouging, corrosion pitting, stresses or cracking associated with those dents. MFL tools have the potential to characterize dents and gouges, but as yet the MFL signals from these features are not sufficiently understood to be used for reliable mechanical damage detection and characterization. In order to reliably use MFL tools for mechanical damage assessment, we need to understand the origin of the MFL signal from dents and gouges. This project addresses that need.

Technical Status

The work in this Quarter was focused on Task 8 "Dent Signal Database", Task 10 "MFL signals from Gaz de France gouged pipeline samples", and Task 13 "Collaboration with DOT Project DTPH56-06-T-000016 (MD1-1)".

The experimental MFL signal patterns from laboratory and pipeline gouges obtained in Tasks 9 and 10 were added to the MFL Signal Database. This included MFL signal patterns from laboratory test gouges and the pipeline gouges available with GDF SUEZ, Paris. A few typical modeled MFL patterns were also added to the database for comparison with experimental results.

The GDF SUEZ gave us access to three nearly perfect gouged samples with negligible dents. One of the samples had a circumferential gouge while the other two contained axial gouges. The gouges had lengths ranging from 95 to 250 mm and widths from 7 to 18 mm. The detailed description of the samples is given under "Results and Conclusions". Both axial and radial MFL measurements were taken on all the three samples with the magnetic field applied along the axial direction. The measurements were taken on the inside surface using specially designed curved pole pieces that matched the pipe diameters to minimize the background flux leakage near the poles. These gouges were also modeled with magnetic finite element modeling and the experimental results were compared with the modeled results from the corresponding geometries.

The work on magnetic finite element modeling of MD1-1 dents was extended to model cylindrical and wedge shaped dents based on the stress information obtained from our structural finite element modeling. The stress information was obtained for the pipeline under a 'no pressure' condition and also in the presence of an internal pressure of 235 MPa. Modeled data for all the three MFL components (axial, radial and circumferential) was produced. The modeled axial results for circular dents were compared with the corresponding decoupled pull test results provided by Mr. Alex Rubinshteyn from the MD1-1 team. There was, in general, a good agreement.

Plans for Future Activity

We have now completed Phase 3 of the proposed contract work. For Phase 4, originally we had proposed to design and build a laboratory rig to create a number of dent+gouge samples. There were a number of limitations to our rig design – it could accommodate only thin plate samples, and prepare them only under unpressurized conditions – however, at the time we were unaware of any alternatives. Fortunately, at the most recent International Pipeline Conference we became familiar with the facilities available at Stress Engineering Services. SES has large-scale denting/gouging facility that is capable of creating dents in pressurized or unpressurized pipe sections. After discussions with SES we are planning to modify our Phase 4 proposal to involve collaboration with SES in the preparation of full-scale dent+gouge pipeline sections.

Furthermore, our work, and informal discussions with PRCI colleagues, has made us aware that there is a significant lack of knowledge regarding the local strain state in and around a gouge. Therefore, in addition to the work with SES, we plan to obtain one of the gouge samples from GDF SUEZ and make detailed strain measurements in and around the gouge, using the neutron diffraction strain measurement facilities at Chalk River, Ontario, an AECL (Atomic Energy Canada Limited) laboratory.

As described above, these modifications are believed to enhance the project and will provide samples that are more representative of actual defects encountered on operating pipeline systems. Accordingly, the project team is discussing the effects of these modifications to the schedule for the upcoming work on the project. The active work on the project will be suspended for a quarter as the details of the approach and contractual terms are discussed and confirmed. We expect to resume active work on the project on approximately April 1, 2009. The program team is coordinating on the development of a contract modification request for PHMSA review and approval.